Indian Journal of Economics and Business
Vol. 20 No. 1 (January-June, 2021)

http://www.ashwinanokha.com/IJEB.php

Barriers to Sustainability in Humanitarian Logistics

Muhammad Khan[1], Abbas Ali[2], Majid Jehangir[3], Noor Hassan[1], Arif Hussain[1], Julija Jacquemod[4]

Affiliation 1: *Institute of Business Studies and Leadership, Abdul Wali Khan University Mardan, 23200, KP, Pakistan,*
Affiliation 2: *Business and legal studies department, University of Siena Italy,*
Affiliation 3: *Department of Business Administration, Changwon National University, Republic of Korea,*
Affiliation 4: *Department of Business, RISEBA University, Latvia*

Corresponding author email: muhammadkhan@awkum.edu.pk

Abstract: The main purpose of this study is to find barriers to sustainability in humanitarian logistics (HL) and to determine their mutual relationship. Applying interpretive structural modeling (ISM) and cross-impact matrix multiplication classification (MICMAC) assessment to develop a hierarchy model of the study variables. The key findings of this study are, the identification of the variables that can be seen as barriers to sustainability in HL, and the ISM approach is applied to determine the group of variables that have perfect control, low dependence, and strategic significance. The hierarchy of the variables reflects a valuable tool for all stakeholders of catastrophe, specifically for governments, donors,as well as humanitarian organizations (HOs)to focus on the identified variables in order to overcome the inhibitors to sustainability in HL, as they are constantly seeking strategies for sustainable HL. This study extends a hierarchy-based model of inhibitors to sustainability in HL through ISM methodology, which has not been investigated before.

Keywords: Sustainability, Humanitarian Logistics, Relief Operations, Interpretive Structural Modeling

1. Introduction

Disasters cause adversity and hardship for people (Bealt, Fernández Barrera, & Mansouri, 2016), badly disturb the concerned population and lead to human, materials, and financial losses that are difficult for a population's capacity by utilizing its resources to control the situation. In the past several years in developing countries, almost two thousand million people have been affected due to hazards related to climate change (Khan, Lee, & Bae, 2019). Disasters cause disabilities, fatalities, casualties, and asset losses and impact people financially and emotionally. Nowadays, the world is facing a major challenge to effectively handle disasters, reduce the vulnerability of the people, and assess and understand the impact of disaster on long-term social welfare and economic growth.

In disaster relief operations (DRO), the key place is occupied by HL (Vitoriano, Ortuño, Tirado, & Montero, 2011), as the cost and participation of logistics account for around 80% of the total DRO (Khan, Yong, &Han, 2019a, 2019b; Nurmala et al., 2017). Furthermore, around 40% is wasted due to ineffective HL (Bealt et al., 2016). (Nurmala et al., 2017) reported that despite the center position of logistics in DRO, HL constantly has lower attention within organizations (Khan, Lee, et al., 2019). HL is the technical (Khan, Parvaiz, et al., 2022; Rabta, Wankmüller, & Reiner, 2018) and an umbrella term (Khan, Lee, et al., 2019) that contains the planning, procurement, storage, inventory management, transportation, and distribution from the starting point to the disaster-prone-area even to the last mile distribution (Khan, Lee, et al., 2019; Rabta et al., 2018) to assess the victims in a cost-efficient way

(Khan, Lee, et al., 2019). HL effectiveness could be compared in terms of reduced lives lost & human suffering (Apte, Gonçalves, & Yoho, 2016; Day, Melnyk, Larson, Davis, & Whybark, 2012).

Due to the enhanced frequency and intensity of disasters and the rising need for relief items, the HL has grown into a significant source of unsustainable processes(Patil, Shardeo, Dwivedi, Madaan, & Varma, 2021).The majority of organizations use sustainability to differentiate their organization from their rivals, decrease costs, and enhance the quality and services for their customers (Guiffrida, Datta, Dey, LaGuardia, & Srinivasan, 2011). For improving the image of the company, doing things properly attracts green customers and overcomes pressures from customers and competitors (Dey, LaGuardia, & Srinivasan, 2011; Lieb & Lieb, 2010). Sustainable logistics means increasing capabilities and minimizing uncertainties and risks (Raut, Mangla, Narwane, Dora, & Liu, 2021). Disaster mitigation and adaptation are important for a sustainable economy in a society. To identify proper remedies to the natural, social, and technical difficulties in the increasingly complicated systems of DRO, attract researchers and economic and political players to study sustainability(Remida, 2015). A successful HL process lessens the urgent requirements of the people quickly and economically with a sustainable decrease in their vulnerability(Cozzolino, 2012) reduces risks, reduces waste, enhances performance, and innovates by creating new, effective ideas that lead to sustainability (Gonzalez et al., 2015; Gunasekaran & Spalanzani, 2012). On the other hand, sustainable HL is the set of skills that allows HOs to structure logistics to accomplish sustainable development(SD) (Gimenez, Sierra, & Rodon, 2012). Sustainability in physical asset management is of the uppermost significance for logistics management because it can abolish energy-intensive storage, decrease travel times, and enhance truckload applications (Dey et al., 2011) that further decrease the number of casualties and can ease the misery of people in the disaster-prone-area.

The term sustainability is commonly used and, since the 1990s, has attracted the attention of a great number of scholars in the field of supply chain (SC) (Rajeev, Pati, Padhi, & Govindan, 2017). In this article, sustainability can be defined as the capability to encourage the coordinated evolution of a complete procedure with a better direction that is valuable to all stakeholders in the context of cultural, environmental, and financial objectives. Bealt et al. (Bealt et al., 2016) stated that HL is the strategic management of the planning, procurement, transportation, and storage of items from the origin to the disaster-prone area, even to the last-mile distribution, in order to efficiently help the victims. In this regard, for an organization to implement sustainable planning in the whole process, the HL function plays a key role (Dey et al., 2011; Goldsby & Stank, 2000; Mollenkopf, Stolze, Tate, & Ueltschy, 2010). In accomplishing this, the manager must utilize assets fully, integrate the various SC elements, and confirm the social systems and ethics that contribute to effective HL and sustainability (Dey et al., 2011). As stated, effective HL decreases survivors' suffering, reduces deaths and asset losses, and lifts the social aspirations of the people affected; therefore, effective HL seems necessary and urgent for SD. In addition, effective HL can lead to performance enhancement and cost reduction (Rossi, Colicchia, Cozzolino, & Christopher, 2013). On the other hand, supply shortages and inequitable distribution (C. Cao, Liu, Tang, & Gao, 2021) and transportation (Jaehn, 2016; Vega-Mejía, Montoya-Torres, & Islam, 2019) create undesirable influences on HL and, ultimately, on SD. Besides, waste and debris from a disaster can damage the environment (Hu & Sheu, 2013). The number of relief items, the total transportation distance and the modes of transportation may seriously affect costs along with sustainability (C. Cao et al., 2021; Jaehn, 2016; Laguna-Salvadó, Lauras, Okongwu, & Comes, 2019; Zhang, Li, Li, & Peng, 2018). In short, multiple periods, inadequate and uncertain SC, and multiple hierarchies challenge SD. A great deal of consideration must be given to integrating such issues in HL for sustainability.

Therefore, the primary objective of the present study is to offer variables for the lack of sustainability in HL and to establish their mutual linkages. More specifically, this study addresses the following questions:

How can practitioners systematically identify and design SD planning for a higher level of effectiveness in HL?

“What variables are inhibitors to sustainability in HL?

“What are the mutual relationships among these factors?” and

“How can these variables be ranked in terms of their importance”.

To achieve these objectives, the article extends a graph-based ISM to visually investigate interdependent and influential powers of inhibitors to sustainability. Shin & Park, (Shin & Park, 2019) reported that ISM approach has been used for investigating a plan of interrelationship among applications and effectiveness assessment in resilient and sustainable SC.

This study contributes to the knowledge of these variables, which can be known as inhibitors to sustainability in HL and need attention of the researchers and professionals. It provides the consciousness of the importance of wisely evaluating decisions interrelated to the relief materials’ SC and provides researchers interested in this theme with guidelines concerning the basic issue of sustainability to be considered. The study findings advance the current theories and introduce the guidelines for more improvement in disaster relief operations (DRO). Implications for disaster risk management are presented, and limitations are explored for further research to develop more sustainable HL operations.

The paper is planned as follows. In section **2**, we outline materials and methods. In section **3**, we present application of the proposed approach. In section **4**, we present results and discussion along with implications and limitations followed by conclusion and references.

2. Materials and Methods

2.1. Literature Review

This section focuses on the barriers to sustainability in HL. The studies considered were from the areas of HL and sustainability. Primarily, the literature was analyzed emphasizing the process and interests related to sustainability in DRO. The studies relevant to HL sustainability are analyzed to determine the research gaps.

The effect of unsustainable production and utilization is detrimental and broad(Dubey, Gunasekaran, Altay, Childe, & Papadopoulos, 2016). The detrimental impacts are important in every economic, cultural, and environmental system(Ali et al., 2020). Ecological deterioration, biodiversity loss, and the increasing frequency and intensity of disaster events threaten the world's economic structure (Sherrington & Moran, 2010). Scholars have analyzed the development of the SC in making economic activities sustainable (Chen et al., 2017; Khan, Khan, et al., 2022). The need to gain a globally sustainable SC has become a major concern among disaster stakeholders (Sabuj, Ali, Hasan, & Paul, 2021). Sustainable SC management pursues the minimization of material waste or lessens the adverse outcome of the organization's value-chain on the environment (Eskandarpour, Dejax, Miemczyk, & Péton, 2015). The combination of economic, ecological, and cultural elements is crucial to gaining a sustainable SC. Whereas economic and social sustainability has gained attention in the humanitarian SC literature, HL sustainability has been usually neglected (Kunz & Gold, 2017).

Existing literature has reached disaster management as a mean for sustainability(Patil et al., 2021). (Haavisto & Kovacs, 2013) have stated that investigating a sustainable SC in DRO is complicated. Intertwined aspects with complicated dynamics, like society, victims, aid-program, and SC, must be incorporated through evaluating sustainability in DRO. (Klumpp, De Leeuw, Regattieri, & De Souza, 2015) have described a sustainable HL as incorporating disaster afflicts’ expectations and SC

complications. (Dubey et al., 2016) have revised this definition and interlinked constructs for HL sustainability. They found agility, adaptability, and alignment to3seriousfeatures.(Kunz & Gold, 2017) have framed a framework for sustainability in the developmental stage of DRO. In addition,(Laguna-Salvadó et al., 2019) have planned an evaluation approach to enhance the sustainability of DRO. They emphasized inconvenience in decision-making and combining sustainability in decisions and pointed outthat sustainability in the SC in disaster is still not in the maturity stage. (C. Cao, Li, Yang, Liu, & Qu, 2018) stated that is in the developmental stage. There are some articles focused on the developmental stage of the disaster(Pomponi, Moghayedi, Alshawawreh, D'Amico, & Windapo, 2019) but mainly have focused on the response phase of the disaster.
(X. Cao, Liang, Chen, & Liu, 2017) have emphasized the minimization of weighted accomplishment times, total carbon emanations, and total emergency costs whereas solving organization distribution problems in sustainable HL. This study has framed a model for dynamic HL integrating equity, approach, and required accomplishment as the 3 principles of sustainability (C. Cao et al., 2018). (Li, Zhang, Cao, Liu, & Qu, 2019) have developed an evolutionary game methodology to examine coordination decisions for SC sustainability in disaster. They investigate ethical and green procurement elements. (Laguna-Salvadó et al., 2019) have framed a decision support structure for integrating sustainability elements in the SC in disaster. This article suggested metrics and performance assessment for sustainable SC in the context of disaster. This study (Khan, Sarmad, Ullah, & Bae, 2020) Provided insights into attaining the sustainable HL through university education by applied Covariance-Based Structure Equation Modeling (CB-SEM) but did not focus on the inhibitors to sustainability in HL. The articles of (Patil et al., 2021) focused on obstacles to sustainability in the medical field of HSC. They identified 20 potential obstacles and used quantitative methodology. It means that in the past decades, the studies have focused on sustainability in the disaster context much more than before.

Table 1: Recent Studies on DRO and Sustainability.

Objective	Method	Outcome	Limitation/Remarks	Source
1. Focused on the environmental sustainability in the developmental phase of disaster.	Multi criteria decision-making	Among the 4 elements of sustainability, the most crucial one is social.	Only focused on the shelter in the developmental phase of disaster.	(Pomponi et al., 2019)
2. offer a definition and frame work for SC sustainability in the disaster context	Regression and ISM	Developed a model for sustainable SC in the disaster context incorporating agility, adaptability and alignment	The study did not focus on the hurdle in the way of HL sustainability.	(Dubey et al., 2016)
3. The study suggests decision-support system (DSS) for SC sustainability in the disaster context	Semi-structured interviews to frame DSS	Offer a multi-objective performance assessment framework &DSS	DSS needs big sample size which is difficult to arrange.	(Laguna-Salvadó et al., 2019)
4. Offer a frame work for SC sustainability in the disaster context.	Case-study	Offer a multi-dimensional sustainability model.	Response phase did not discuss.	(Kunz & Gold, 2017)

5.Focus on coordination between the private sector & HOs to gain SC sustainability in the disaster context.	Evolutionary Game Models	Offer insights to attaining SC sustainability in the disaster context through collaboration	Did not discuss procurement and transportation element of humanitarian SC.	(Li et al., 2019)
6. Describe the medical support in huge-scale disaster response	Case-study and interview	Found the components influencing the performance of humanitarian medical SC	Did not discuss the environmental influence.	(Dolinskaya, Besiou, & Guerrero-Garcia, 2018)
7. Find and classifies the enablers of greening humanitarian SC	Interview	Suggested a hierarchical structure of enablers	Heterogeneity of aid material is ignored	(Bag, Luthra, Venkatesh, & Yadav, 2020)
8. Revise the logistics framework for sourcing, supply, and distribution of Medical and Pharmaceutical products (MPP) in relief aid.	Literature review	Identified limited practical logistics framework for effective logistics of MPP.	Ask to search the logistics of MPP.	(Babatunde, Oloruntoba, & Agho, 2020)
9. Education for sustainable development in HL	CB-SEM	offer insights to reaching the sustainable HL through university education	Except for education, other factors of sustainability in HL are ignored.	(Khan, Sarmad, et al., 2020)
10. Barriers to sustainability in humanitarian medical SC	Fuzzy bestworst method & analytic network process	Focus on medical supply and identify barriers regarding the topic	Did not focus on HL, which can cause success or failure of DRO.	(Patil et al., 2021)

2.2. Identifying the inhibitors to sustainability in humanitarian logistics (HL)

The section focuses on the challenges of the HL. These challenges intensify the waste of scarce resources and lead to harm to the environment. Multiple articles have suggested frameworks, ways, and quantitative solutions to decrease wastage. Resolutions for the inhibitors inhibiting the execution of sustainable practices have seldom been focused on. (Sarkis, Spens, & Kovács, 2013) have offered insights into eliminating the inhibitors to green exercise in DRO. This article found many inhibitors but never try to find the level of impact of those inhibitors. The review by(Babatunde et al., 2020), have recorded8 related articles on the managerial side of medical items in DRO. The sustainability aspect of HL has not received consideration in these works. (Patil et al., 2021)focused on medical supply and identify six categories of barriers whereas applied fuzzy best-worst method & analytic network process. This study did not focus on the HL sustainability. Therefore, a complete consideration of the inhibitors that inhibit or restrict sustainability exercises in the HL process is the research gap. Consequently, this study tends to adopt quantitatively (ISM & MICMAC) approaches to develop the operational performance of the HL in association with sustainability through identified inhibitors to sustainability.

This section focuses on the HL and describes its operating and logistical attributes. For the present work, the HL can be defined as the system of planning, executing, and controlling the effectively and efficiently flow and storing of relief materials along with relevant data from beginning point to end point for consumption to fulfill the victims, need(Thomas & Mizushima, 2005). Importantly, HL is the process and structures elaborated mobilizing individuals, resources and experience and learning to help afflicts of calamity. A list of 19prospectiveinhibitors to sustainability in the HL was obtained from the literature. The transformation of the HL process into sustainability is not an easy and simple task. These 19 very relevant variables were identified and categorized into five different groups (see Table 3) through the brainstorming technique. The brainstorming approach and these identified variables are further discussed below. A panel of 14 experts was called and discussed to finalize the list of inhibitors.

2.3. The brainstorming method

According to the step-by-step rules of this methodology, the first and second steps are covered by the brainstorming technique. In this research, to find the appropriate association among the inhibitors to sustainability in HL, academic experts with research interest in the area of SCM and officers with administrative experience in the relevant field were consulted. Employees from HOs and also academicians, based on their availability and experience were selected to participate in a brainstorming session to choose the inhibitors to sustainability in HL. An informal visit to the organizations of the chosen experts was undertaken to determine their perception of the role of sustainability in HL. Formal invitations were sent to the selected persons for participation in this activity, planned in Pakistan in October 2021. Out of 23, just 14 experts joined with 9 being absent, mostly owing to their busy schedules. These participants were researchers in business and chief executive officers and administrators engaged in managing SC of their particular organizations, for detailed profiles see Table 2.

Table 2: Profile and description of the participants

S/No	Sector	Position	Experience
1	International Humanitarian Organization	Logistician	7 Years
2	International Humanitarian Organization	Field Officer	8 Years
3	International Humanitarian Organization	Transportation	8 Years
4	United Nations Organization	SC Manager	13 Years
5	Local nongovernmental organization	Procurement Officer	3 Years
6	Local nongovernmental organization	Procurement Officer	5 Years
7	Local nongovernmental organization	Logistics Manager	8 Years
8	Local nongovernmental organization	Operation Manager	5 Years
9	Academic	Professor in the Field	19 Years
10	Academic	Associate Professor in the field	13 Years
11	Academic	Associate Professor in the field	14 Years
12	Academic	Research Assistant in the Field	7 Years
13	Government Administrator	National Disaster Management Authority Officer	8 Years
14	Local Government Administrator	Provincial Disaster Management Authority Officer	6 Years

For the first step of methodology, in preparation for the brainstorming session, literature associated with sustainability and HL was emailed to the experts to get knowledge about the inhibitors to sustainability in HL. In the workshop, they were requested to find inhibitors to sustainability in HL. After three sessions, 31 inhibitors were agreed upon and lastly reduced to 19 as some were combined and about. After the finalization of the first session, the resource persons were asked to pick out the interrelationships among these 19 inhibitors which are considered the second step of the proposed methodology.

This session failed to frame the relationships among the overall variables, so a second meeting was carried out to accomplish it. In this session, a list of variables was accepted and a diagram denoting the interrelationships was circulated among the attendants for any improvement. Instead of some discrepancy over the associations among the inhibitors during the opening debate, the ultimate interrelationships were developed through mutual consent among these resource persons. With the consensus among the participants regarding these 19 variables, the inhibitors were applied to extend the ISM-based model. The inhibitors found can be positioned into different groups as per their scope of influence (see Table 3).

Table 3. Barriers' categorization

Categorization	Barriers	Code	References
Operational Issues	Lack of preparation and planning	O1	(Elalouf, Hovav, Tsadikovich, & Yedidsion, 2015; Laguna-Salvadó et al., 2019; Shi, Wang, & Shi, 2019)
	Lack of information management	O2	(Holguín-Veras & Jaller, 2012; Kamba, Ireeta, Balikuna, & Kaggwa, 2017; McDonald, Fabbri, Parker, Williams, & Bero, 2019)
	Poor Warehouse management	O3	(Babatunde et al., 2020; Raila & Anderson, 2017)
	Poor performance measurement system	O4	(Haavisto & Kovács, 2014; Khan, Hussain, et al., 2020; Narayana, Pati, & Padhi, 2019)
Logistics Issues	Poor resource utilization	L1	(John, Gurumurthy, Soni, & Jain, 2019)
	Poor management and disposal of donated materials	L2	(Babatunde et al., 2020; Raila & Anderson, 2017)
	Inefficient traffic management	L3	(Viegas, Bond, Vaz, & Bertolo, 2019)
Human Related Issues	Cultural barriers	H1	(Kunz & Gold, 2017; Viegas et al., 2019)
	Volunteers' uncertainties about relief efforts	H2	(Asgary & Lawrence, 2020)
	Local People Involvement/Political Interference	H3	(Khan, Hussain, et al., 2020)
	Multiple Stakeholders	H4	(Khan, Hussain, et al., 2020; Viegas et al., 2019)
	Lack of proper education and training	H5	(Asgary & Lawrence, 2020)
Funding Related Issues	Uncertainty in funding process	F1	(Burkart, Besiou, & Wakolbinger, 2016)

	Poor communication among stakeholders	F2	(McDonald et al., 2019)
	Remoteness between the funders and disaster area	F3	(Holguín-Veras & Jaller, 2012; Muller & Whiteman, 2009)
	Financial constraints	F4	(Khan, Hussain, et al., 2020)
Exogenous Issues	Unsupportive policy	E1	(Narayana et al., 2019; Raila & Anderson, 2017; Viegas et al., 2019)
	Limited and conflicting regulations	E2	(Asgary & Lawrence, 2020; Sabri, Zarei, & Harland, 2019)
	Complex and risky environment	E3	(Sabri et al., 2019)

2.4. ISM methodology and Building the ISM model

The brainstorming section above reveals several variables, which are inhibitors to sustainability in HL. It is very important to know the contextual relationship among these variables. The best possible way to achieve this is by applying interpretive structure modeling (ISM) methodology, which can effectively bring forward these interrelationships.

This ISM method is explanatory because resource persons have to explain whether and how these inhibitors have association. It is also structural because based on the interrelationships a complete construct is established from the complicated variables set. ISM is a modeling method because the whole construct of the mechanism is described in a digraph. This technique is a group learning procedure but individually is also applicable. The following steps are considered in this method.

Step 1. The variables impacting sustainability in HL are identified through brainstorming techniques **(See section 2.3)**

Step 2. A structural relationship is constructed among the identified holders obtained in the first step, with regards to which pairs of variables will be portrayed as seen in section 2.3)

Step 3. A structural self-interaction matrix (SSIM) is framed for the variables, reflecting the doublet associations of the inhibitors of the structure in consideration. **(See Table 1)**

Step 4. A reach ability matrix is framed from the SSIM, then scanned for transitivity. The basic assumption made in ICM for transitivity of the contextual interrelationship is that if an inhibitors L is interrelated to M and if M is interrelated to N, then L and N are interrelated. **(See Table 4)**

Step 5. In this step, the framed reach ability matrix is further categorized into 10 levels. **(See table 5 to 14 Iteration i-x)**

Step 6. In this step from the reach ability matrix, a direct graph is framed, and the associations of transitive are detached. **(See Figure 2)**

Step 7. The digraph drawn in the previous step is transformed into an ISM model, by putting nodes of inhibitors with statements. **(See Figure 1)**

Step 8. The ISM model is examined for any necessary modification and any conceptual inconsistencies.

3. Application of the Proposed Approach

3.1. Structural Self-Interaction Matrix (SSIM)

The third step was the use of the SSIM approach. To examine the 19variables of inhibitors to sustainability in HL, a structural interrelationship of the exasperate type was chosen. Considering the related relation for each inhibitor, the presence of a link between any two inhibitors (i and j) and the related order of the association is examined. Four indications are utilized to represent the direction of the relation between the inhibitors (i and j):

V: inhibitor i will intensify inhibitor j;

A: inhibitor j will intensify inhibitor i;

X: inhibitor i and j will intensify each other; and

O: inhibitor i and j are independent.

Accordingly, the indications V, A, X, and O, are used to portray the nature and existence of links between the 19variables as seen in Table 4. Some cases are given below.

Inhibitor O1 (Lack of preparation and planning) intensifies inhibitor O2 (Lack of information management). When there is a lack of preparation and planning there will be a lack of information management. This relationship in Table 4 is represented by an indication V.

Inhibitor L1 “Poor resource utilization” is intensified by inhibitor H2 “Volunteers uncertainties of relief efforts”. If the volunteers don’t know about the process, effect, and effectiveness of relief activities the resources will not be utilized properly and will be wasted. Therefore, the indication is A.

Inhibitor E2“Limited and conflicting regulations” and inhibitor E3 “Complex and risky environment” intensify and affect each other. If there are limited and conflicting regulations, there will be a risky and complex environment. On the other hand, in terms of HL, if there is risky environment, there will be limited and conflicting regulations. So, it is difficult to get funds. This association is represented by indication X.

Inhibitor F1 “Uncertainty in funding process” and inhibitor H5 “Lack of proper education and training” has no relationship, as revealed by O.

Table 4. Structural Self-Interaction Matrix (SSIM)

pi Inhibitors	*pj Inhibitors*																		
	E3	**E2**	**E1**	**F4**	**F3**	**F2**	**F1**	**H5**	**H4**	**H3**	**H2**	**H1**	**L3**	**L2**	**L1**	**04**	**03**	**02**	**01**
1. O1	X	O	O	A	A	A	X	A	A	A	A	X	V	V	V	V	V	V	1
2. O2	A	O	O	X	A	A	A	X	A	O	X	A	V	V	V	X	V	1	
3. O3	A	O	O	A	O	A	O	A	A	O	O	O	O	V	X	A	1		
4. O4	A	X	A	A	A	A	A	A	X	O	O	O	A	V	A	1			
5. L1	O	X	O	A	A	A	A	A	A	O	A	O	X	O	1				
6. L2	A	O	O	A	A	V	X	A	A	X	X	A	O	1					
7. L3	A	A	A	A	O	O	A	A	A	A	O	O	1						
8. H1	O	O	O	O	O	X	O	V	X	V	V	1							
9. H2	A	A	A	A	O	A	A	A	X	X	1								
10. H3	A	A	A	V	A	A	X	X	X	1									
11. H4	A	A	V	V	V	V	V	V	1										
12. H5	A	X	A	A	A	O	O	1											
13. F1	A	A	A	X	A	A	1												
14. F2	V	V	V	V	A	1													
15. F3	A	X	V	V	1														
16. F4	A	A	A	1															
17. E1	X	X	1																
18. E2	X	1																	
19. E3	1																		

3.2. Reachability Matrix

The fourth phase is the conversion of the SSIM into a twofold matrix, to develop a key reachability matrix from SSIM. Hence, SSIM is transformed into the primary reachability matrix by taking the place of the 4 symbols of SSIM (e.g., V, A, X, or O) at 1s or 0s.

For this substitution (V, A, X, O by 1 or 0 as suitable) the rules are as follows:

(1) In the SSIM, if the (i, j) symbol is V, later the (i, j) digit in the reachability matrix should be 1 and the (j, i) digit should be 0.

(2) If the (i, j) symbol in the SSIM is A, afterward the (i, j) digit in the reachability matrix should be 0 and the (j, i) digit should be 1.

(3) If the (i, j) symbol in the SSIM is X, next to the (i, j) digit in the reachability matrix must be 1 and the (j, i) digit should also be 1.
(4) If the (i, j) symbol in the SSIM is O, afterward the (i, j) digit in the reachability matrix should be 0 and the (j, i) digit should also be 0.
Subsequently, the rules are to construct the final reachability matrix, after integrating the transitivity (if an inhibitor A is connected to B and B connected to C, therefore A and C are connected), as seen in **Table 5**.

Table 5. Final reachability matrix

	pj Inhibitors																			
	O1	**O2**	**03**	**04**	**L1**	**L2**	**L3**	**H1**	**H2**	**H3**	**H4**	**H5**	**F1**	**F2**	**F3**	**F4**	**E1**	**E2**	**E3**	**Driver**
1. O1	1	1	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0	1	**10**
2. O2	0	1	1	1	1	1	1	0	1	0	0	1	0	0	0	1	0	0	0	**9**
3. O3	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**3**
4. O4	0	1	1	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	**5**
5. L1	0	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	**5**
6. L2	0	0	0	0	0	1	0	0	1	1	0	0	1	1	0	0	0	0	0	**5**
7. L3	0	1	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	**4**
8. H1	1	0	0	0	0	1	0	1	1	1	1	1	0	1	0	0	0	0	0	**8**
9. H2	1	1	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	**6**
10. H3	1	1	0	0	0	1	1	0	1	1	1	1	1	0	0	1	0	0	0	**10**
11. H4	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	**16**
12. H5	1	1	0	1	1	1	1	0	1	1	0	1	0	0	0	0	0	1	0	**10**
13. F1	1	1	1	1	1	1	1	0	1	1	0	0	1	0	0	1	0	0	0	**11**
14. F2	1	1	1	1	1	0	0	1	1	1	0	0	1	1	0	1	1	1	1	**14**
15. F3	1	0	0	1	1	1	0	0	0	1	0	1	1	1	1	1	1	1	0	**12**
16. F4	1	0	1	1	1	1	1	0	1	0	0	1	1	0	0	1	0	0	0	**10**
17. E1	0	1	0	1	0	0	1	0	1	1	0	1	1	0	0	1	1	1	1	**11**
18. E2	0	1	0	1	1	0	1	0	1	1	1	1	1	0	1	1	1	1	1	**14**
19. E3	1	1	1	1	0	1	1	0	1	1	1	1	1	0	0	1	1	1	1	**15**
Dependence	**10**	**11**	**10**	**14**	**12**	**14**	**12**	**4**	**13**	**12**	**7**	**10**	**11**	**5**	**3**	**10**	**6**	**7**	**5**	

In Table 5, the driver and the dependence of each variable represented. Those variables which affect containing itself is the driver for those particular variables. On the other hand, those variables affected by its containing itself are dependent on that particular variable. Both of these powers are applied in the MICMAC examination, where these variables are categorized into 4 different categories of autonomous, interconnection, dependent and independent inhibitors.

Table 6. Iteration i

Inhibit or *pi*	Reachability Set R(*pi*)	antecedent Set A(*pi*)	Intersection set R(*pi*) ∩ A(*pi*)	Level
1. O1	1, 2, 3,4,5,6,7, 8, 13,19	1,8,9,10,11,12,13,14,15,16,19	1,13,19	
2. O2	2,3,4,5,6,7,9,12,16	1,2,4,7,9,10,12,13,14, 17,18,19	2, 4,7,9	
3. O3	3,5,6	1,2,3,4,5,11,13,14,16,19	3,5	
4. O4	2,3,4,6,11	1,2,4,5,7,11,12,13,14,15,16,1 7,18,19	2,4,11	**I**
5. L1	3,4,5,7,18	1,2,3,5,7,11,12,13,14,15,16,1 8	3,5,7,18	
6. L2	6,9,10,13,14	1,2,3,4,6,8,9,10,11,12,13,15,1 6,19	6,9,10,13	**I**
7. L3	2,4,5,7	1,2,5,7,10,11,12,13,16,17,18, 19	2,5,7	
8. H1	1,6,8,9,10,11,12,14	1,8,11,14	1,8,11,14	
9. H2	1,2,6,9,10,11	2,6,8,9,10,11,12,13,14,16,17, 18,19	2,6,9,10,11	
10. H3	1,2,6,7,9,10,11,12,14,16	6,8,9,10,11,12,13,14,15,17,18 ,19	6,9,10,11,12,14	
11. H4	1,3,4,5,6,7,8,9,10,11,12,13,14,1 5,16,17	4,8,9,10,11,18,19	4,8,9,10,11	
12. H5	1,2,4,5,6,7,9,10,12,18	2,8,10,11,12,15,16,17,18,19	2,10,12,18	
13. F1	1,2,3,4,5,6,7,9,10,13,16	1,6,10,11,13,14, 15,16,17,18,19	1,6,10,13,16	
14. F2	1,2,3,4,5,8,9,10,13,14,16,17,18, 19	6,8,11,14,15	8,10,14	
15. F3	1,4,5,6,10,12,13,14,15,16,17,18	11,15,18	15,18	
16. F4	1,3,4,5,6,7,9,12,13,16	2,10,11,13,14,15,16,17,18,19	13,16	
17. E1	2,4,7,9,10,12,13,16,17,18,19	11,14,15,17,18,19	17,18,19	
18. E2	2,4,5,7,9,10,11,12,13,15,16,17, 18,19	5,12,14,15,17,18,19	5,12,15,17,18,19	
19. E3	1,2,3,4,6,7,910,11,12,13,16,17, 18,19	1,14,17,18,19	1,17,18,19	

3.3. Level partitions

From **Table 5,** for each inhibitor, reachability and antecedent sets can be obtained. The reachability set contains the inhibitors themselves and the other inhibitors that they may influence. Therefore, for each inhibitor pi, reachability must be defined by setting R (pi) as the set of inhibitors accessible from pi. R (pi) can be defined by examining the row of interest in **Table 5,** of the final reachability matrix regarding pi. Similarly, the variable that the column denotes is then included in a suitable row in the R (pi) column in the table of Iteration.

Table 7. Iteration ii

Inhibitor *pi*	Reachability Set R(*pi*)	antecedent Set A(*pi*)	Intersection set R(*pi*) ∩ A(*pi*)	Level
1. O1	1, 2, 3,4,5,6,7, 8, 13,19	1,8,9,10,11,12,13,14,15,16,19	1,13,19	
2. O2	2,3,4,5,6,7,9,12,16	1,2,4,7,9,10,12,13,14, 17,18,19	2, 4,7,9	
3. O3	3,5,6	1,2,3,4,5,11,13,14,16,19	3,5	
5. L1	3,4,5,7,18	1,2,3,5,7,11,12,13,14,15,16, 18	3,5,7,18	
7. L3	2,4,5,7	1,2,5,7,10,11,12,13,16,17,18 ,19	2,5,7	
8. H1	1,6,8,9,10,11,12,14	1,8,11,14	1,8,11,14	
9. H2	1,2,6,9,10,11	2,6,8,9,10,11,12,13,14,16,17 ,18,19	2,6,9,10,11	**II**
10. H3	1,2,6,7,9,10,11,12,14,16	6,8,9,10,11,12,13,14,15,17,18,19	6,9,10,11,12,14	
11. H4	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17	4,8,9,10,11,18,19	4,8,9,10,11	
12. H5	1,2,4,5,6,7,9,10,12,18	2,8,10,11,12,15,16,17,18,19	2,10,12,18	
13. F1	1,2,3,4,5,6,7,9,10,13,16	1,6,10,11,13,14, 15,16,17,18,19	1,6,10,13,16	
14. F2	1,2,3,4,5,8,9,10,13,14,16,17,18, 19	6,8,11,14,15	8,10,14	
15. F3	1,4,5,6,10,12,13,14,15,16,17,18	11,15,18	15,18	
16. F4	1,3,4,5,6,7,9,12,13,16	2,10,11,13,14,15,16,17,18,19	13,16	
17. E1	2,4,7,9,10,12,13,16,17,18,19	11,14,15,17,18,19	17,18,19	
18. E2	2,4,5,7,9,10,11,12,13,15,16,17, 18,19	5,12,14,15,17,18,19	5,12,15,17,18,19	
19. E3	1,2,3,4,6,7,910,11,12,13,16,17, 18,19	1,14,17,18,19	1,17,18,19	

In addition, the antecedent set contains the inhibitors themselves and the inhibitors that they may impact. For every inhibitor pj, an antecedent set a (pj) can be described that is the set of inhibitors that approaches pj. A (pj) can be defined by examining the column that concurs with pj. For each row which consists of 1 in column pj of the table of the final reachability matrix, the inhibitors that row denotes are located in A (pj), and for the whole inhibitors when i = j, A (pi) = A (pj).

Table 8. Iteration iii

Inhibit or *pi*	Reachability Set R(*pi*)	antecedent Set A(*pi*)	Intersection set R(*pi*) ∩ A(*pi*)	Level
1. O1	1, 2, 3,4,5,6,7, 8, 13,19	1,8,9,10,11,12,13,14,15,16 ,19	1,13,19	
2. O2	2,3,4,5,6,7,9,12,16	1,2,4,7,9,10,12,13,14, 17,18,19	2, 4,7,9	
3. O3	3,5,6	1,2,3,4,5,11,13,14,16,19	3,5	
5. L1	3,4,5,7,18	1,2,3,5,7,11,12,13,14,15,1 6,18	3,5,7,18	**III**
7. L3	2,4,5,7	1,2,5,7,10,11,12,13,16,17, 18,19	2,5,7	**III**
8. H1	1,6,8,9,10,11,12,14	1,8,11,14	1,8,11,14	
10. H3	1,2,6,7,9,10,11,12,14,16	6,8,9,10,11,12,13,14,15,17 ,18,19	6,9,10,11,12,14	**III**
11. H4	1,3,4,5,6,7,8,9,10,11,12,13,14,1 5,16,17	4,8,9,10,11,18,19	4,8,9,10,11	
12. H5	1,2,4,5,6,7,9,10,12,18	2,8,10,11,12,15,16,17,18,1 9	2,10,12,18	
13. F1	1,2,3,4,5,6,7,9,10,13,16	1,6,10,11,13,14, 15,16,17,18,19	1,6,10,13,16	
14. F2	1,2,3,4,5,8,9,10,13,14,16,17,18, 19	6,8,11,14,15	8,10,14	
15. F3	1,4,5,6,10,12,13,14,15,16,17,18	11,15,18	15,18	
16. F4	1,3,4,5,6,7,9,12,13,16	2,10,11,13,14,15,16,17,18, 19	13,16	
17. E1	2,4,7,9,10,12,13,16,17,18,19	11,14,15,17,18,19	17,18,19	
18. E2	2,4,5,7,9,10,11,12,13,15,16,17, 18,19	5,12,14,15,17,18,19	5,12,15,17,18,19	
19. E3	1,2,3,4,6,7,910,11,12,13,16,17, 18,19	1,14,17,18,19	1,17,18,19	

In the hierarchy, the inhibitor numbersO4 and L2 which are poor performance measurement systems and Poor management and disposal of donated materials, these inhibitors are on top. Because there is no single inhibitor that is above these mentioned inhibitors. Subsequently, the reachability set for a high-level inhibitor pi consists of the inhibitor by itself and other inhibitors at the same level that the inhibitor can reach, such as the elements of a strongly linked subset.

Table 9. Iteration iv

Inhibitor *pi*	Reachability Set R(*pi*)	antecedent Set A(*pi*)	Intersection set R(*pi*) ∩ A(*pi*)	Level
1. O1	1, 2, 3,4,5,6,7, 8, 13,19	1,8,9,10,11,12,13,14,15,16,19	1,13,19	
2. O2	2,3,4,5,6,7,9,12,16	1,2,4,7,9,10,12,13,14, 17,18,19	2, 4,7,9	IV
3. O3	3,5,6	1,2,3,4,5,11,13,14,16,19	3,5	
8. H1	1,6,8,9,10,11,12,14	1,8,11,14	1,8,11,14	
11. H4	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17	4,8,9,10,11,18,19	4,8,9,10,11	
12. H5	1,2,4,5,6,7,9,10,12,18	2,8,10,11,12,15,16,17,18,19	2,10,12,18	
13. F1	1,2,3,4,5,6,7,9,10,13,16	1,6,10,11,13,14, 15,16,17,18,19	1,6,10,13,16	IV
14. F2	1,2,3,4,5,8,9,10,13,14,16,17,18,19	6,8,11,14,15	8,10,14	
15. F3	1,4,5,6,10,12,13,14,15,16,17,18	11,15,18	15,18	
16. F4	1,3,4,5,6,7,9,12,13,16	2,10,11,13,14,15,16,17,18,19	13,16	
17. E1	2,4,7,9,10,12,13,16,17,18,19	11,14,15,17,18,19	17,18,19	
18. E2	2,4,5,7,9,10,11,12,13,15,16,17,18,19	5,12,14,15,17,18,19	5,12,15,17,18,19	
19. E3	1,2,3,4,6,7,910,11,12,13,16,17,18,19	1,14,17,18,19	1,17,18,19	

Afterward, the connection of these inhibitors sets is acquired for the entire inhibitors and the levels of different inhibitors are defined. The inhibitors for that the sets of reachability and the connection are the same are captured at the top level of the ISM hierarchy.

Table 10. Iteration v

Inhibitor *pi*	Reachability Set R(*pi*)	antecedent Set A(*pi*)	Intersection set R(*pi*) ∩ A(*pi*)	Level
1. O1	1, 2, 3,4,5,6,7, 8, 13,19	1,8,9,10,11,12,13,14,15,16, 19	1,13,19	V
3. O3	3,5,6	1,2,3,4,5,11,13,14,16,19	3,5	V
8. H1	1,6,8,9,10,11,12,14	1,8,11,14	1,8,11,14	
11. H4	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17	4,8,9,10,11,18,19	4,8,9,10,11	
12. H5	1,2,4,5,6,7,9,10,12,18	2,8,10,11,12,15,16,17,18,19	2,10,12,18	V
14. F2	1,2,3,4,5,8,9,10,13,14,16,17,18,19	6,8,11,14,15	8,10,14	
15. F3	1,4,5,6,10,12,13,14,15,16,17,18	11,15,18	15,18	
16. F4	1,3,4,5,6,7,9,12,13,16	2,10,11,13,14,15,16,17,18, 19	13,16	V
17. E1	2,4,7,9,10,12,13,16,17,18,19	11,14,15,17,18,19	17,18,19	
18. E2	2,4,5,7,9,10,11,12,13,15,16,17,18, 19	5,12,14,15,17,18,19	5,12,15,17,18,19	
19. E3	1,2,3,4,6,7,910,11,12,13,16,17,18, 19	1,14,17,18,19	1,17,18,19	

The upper-level inhibitors are those inhibitors that do not affect the other inhibitors above their particular level in the hierarchy. It means that for an upper-level inhibitor, the antecedent consists of the inhibitor itself, the inhibitor which reaches it from the lower levels, and also any elements of an intensely connected subset corresponding to pi in the top level. Subsequently, the intersection of the sets of reachability and the antecedent is the similar since the set of reachability is at the top level.

Table 11. Iteration vi

Inhibitor *pi*	**Reachability Set R(*pi*)**	**antecedent Set A(*pi*)**	**Intersection set R(*pi*) ∩ A(*pi*)**	**Level**
8. H1	1,6,8,9,10,11,12,14	1,8,11,14	1,8,11,14	
11. H4	1,3,4,5,6,7,8,9,10,11,12,13,14,15,16,17	4,8,9,10,11,18,19	4,8,9,10,11	**VI**
14. F2	1,2,3,4,5,8,9,10,13,14,16,17,18,19	6,8,11,14,15	8,10,14	
15. F3	1,4,5,6,10,12,13,14,15,16,17,18	11,15,18	15,18	
17. E1	2,4,7,9,10,12,13,16,17,18,19	11,14,15,17,18,19	17,18,19	
18. E2	2,4,5,7,9,10,11,12,13,15,16,17,18,19	5,12,14,15,17,18,19	5,12,15,17,18,19	**VI**
19. E3	1,2,3,4,6,7,910,11,12,13,16,17,18,19	1,14,17,18,19	1,17,18,19	

It should also be noted that when the variable in question is not a variable of the upper level, the reachability set will consist of variables from higher levels, and the connection of the sets of reachability and antecedents will be different from the set of reachability. Nevertheless, a variable *pi* is a top-level variable if R(*pi*) = R(pi) ∩ A(*pi*).

Table 12. Iteration vii

Inhibitor *pi*	**Reachability Set R(*pi*)**	**antecedent Set A(*pi*)**	**Intersection set R(*pi*) ∩ A(*pi*)**	**Level**
8. H1	1,6,8,9,10,11,12,14	1,8,11,14	1,8,11,14	
14. F2	1,2,3,4,5,8,9,10,13,14,16,17,18,19	6,8,11,14,15	8,10,14	
15. F3	1,4,5,6,10,12,13,14,15,16,17,18	11,15,18	15,18	
17. E1	2,4,7,9,10,12,13,16,17,18,19	11,14,15,17,18,19	17,18,19	**VII**
19. E3	1,2,3,4,6,7,910,11,12,13,16,17,18,19	1,14,17,18,19	1,17,18,19	

As soon as the top-level inhibitors are recognized, it is detached from the matrix. After, a similar process is repeated to identify the inhibitors in the coming level.

Table 13. Iteration viii

Inhibitor *pi*	**Reachability Set R(*pi*)**	**antecedent Set A(*pi*)**	**Intersection set R(*pi*) ∩ A(*pi*)**	**Level**
8. H1	1,6,8,9,10,11,12,14	1,8,11,14	1,8,11,14	
14. F2	1,2,3,4,5,8,9,10,13,14,16,17,18,19	6,8,11,14,15	8,10,14	**VIII**
15. F3	1,4,5,6,10,12,13,14,15,16,17,18	11,15,18	15,18	
19. E3	1,2,3,4,6,7,910,11,12,13,16,17,18,19	1,14,17,18,19	1,17,18,19	**VIII**

The procedure is repeated until the level of every inhibitor is developed, as can be seen inTables 6, to Table 14. These levels are useful in establishing the graph and the ISM Model.

Table 14. Iteration ix,x

Inhibitor *pi*	Reachability Set R(*pi*)	antecedent Set A(*pi*)	Intersection set R(*pi*) ∩ A(*pi*)	Level
8. H1	1,6,8,9,10,11,12,14	1,8,11,14	1,8,11,14	**IX**
15. F3	1,4,5,6,10,12,13,14,15,16,17,18	11,15,18	15,18	**X**

4. Results and Discussion

4.1. Building the ISM-based model

The primary goal of this study is to bring constant development within HL through the recognition of the inhibitors to HL sustainability. HL is continuously improving and is being examined progressively. The present study has attempted to frame a model into practice. Significantly, the paper is shown variables sets integrating HL sustainability. The study results are the validation that sustainability can be enhanced through the work on the paper variables in the disaster context. These findings are imperative as it confirms the variables to inhibitors to HL sustainability in an easy mean than that of prior articles. Scholars and professionals require to take a more dynamic assessment of inhibitors to HL sustainability. Several variables affect the transformation of HL into sustainable HL. Therefore, this is one of the complicated issues. These variables are in proper sequence and direction in the ISM model and express the current situation instead of any single variable considered in isolation. Therefore, ISM is a perfect approach because it provides a complete structure of the variables. This approach brings forward the invisible and poorly structured models into a clear, transparent, and comprehensive system as presented graphically. From Table 5, the study model is drawn via lines of edges & nodes and represented by a digraph as seen in Figure 1. Finally, the digraph is transformed into the ISM model as presented in Figure 2. The relationship between two variables (*j to i*, *i to j*) is indicated by an arrow.

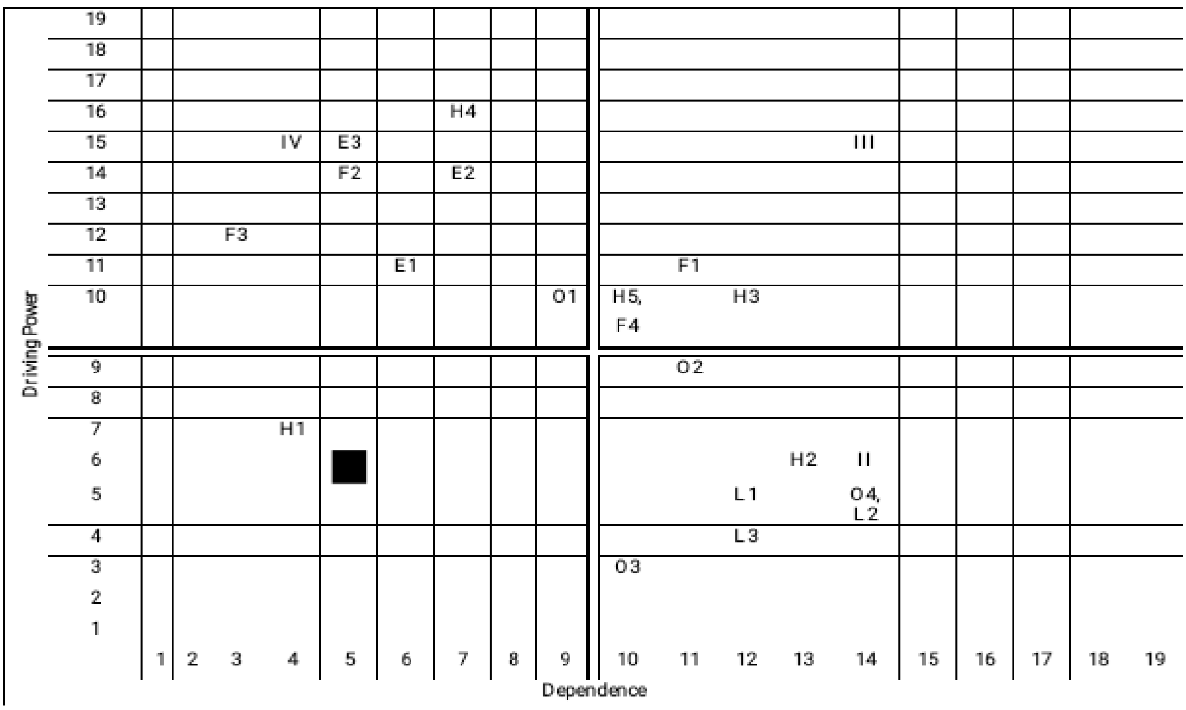

Figure 1. Driver power and dependence diagram

4.2. MICMAC analysis

This section examines the driver and the reliance on the inhibitors, which is the main purpose of MICMAC analysis (Faisal, 2010; Mandal & Deshmukh, 1994). These inhibitors are categorized into 4 different quadrants (See Figure 1). The first quadrant is called the autonomous with holders. They have very weak driver power and reliance and are mostly out of the system. The second quadrant contains the response inhibitors. These inhibitors have very strong reliance but very weak driving power. The third quadrant contains the linking inhibitors that have both strong driving and reliance power. They are uniquely unsteady because any action on these inhibitors can impact the other variables and also themselves. The fourth quadrant contains independent inhibitors. They have very strong driving power but very weak reliance. A variable that has very strong driving power is considered a key variable (See Table 5). The entries in Table 5 of "1" in the rows and columns reflect the driver and dependence, respectively. From Table 5, Figure 1of the driver power and dependency diagram is constructed.

In this study, only one inhibitor in the autonomous quadrant reflects that the H1 (cultural barrier) inhibitor may be taken into account as detached from the system, nevertheless, there are some vital connections with the system. The next class (II) of the variables are response variables. They are7 variables, such as O2 (Lack of information management), O3 (Poor warehouse management), O4 (Poor performance measurement system), L1 (Poor resource utilization), L2 (Poor management and disposal of donated materials), L3 (Inefficient traffic management) and H2 (Volunteers uncertainties of relief efforts). They have high reliance but very low control power and in fact, these variables have these characteristics. The variables reveal that the HOs along with other stakeholders require to know how these inhibitors should be dealt with by knowing their dependence on the inhibitors at the down level in the ISM model. H3 (Local People Involvement/Political Interference), H5 (Lack of proper education and training), F1 (Uncertainty in funding process), and F4 (Financial constraints) fall in the group of interconnection inhibitors. These inhibitors are the most crucial and distinctive as these are impacted by the group of inhibitors in quadrant II. Moreover, these variables influence the variables in quadrant IV. In other words, any changes in quadrant II will not only affect the variables in quadrant III but also in quadrant IV. Therefore, these variables are performing the duty of interconnection between quadrants II and IV. The fourth quadrant of variables consists of O1 (Lack of preparation and planning), H4 (Multiple Stakeholders), F2 (Poor communication among stakeholders), F3 (Remoteness between the funders and disaster area), E1(Unsupportive policy), E2 (Limited and conflicting regulations) andE3 (Complex and risky environment). These 7 inhibitors are the highest driving power and having lowest reliance. To have strong driving power these inhibitors are of high importance in the system and consider originators of the issue.

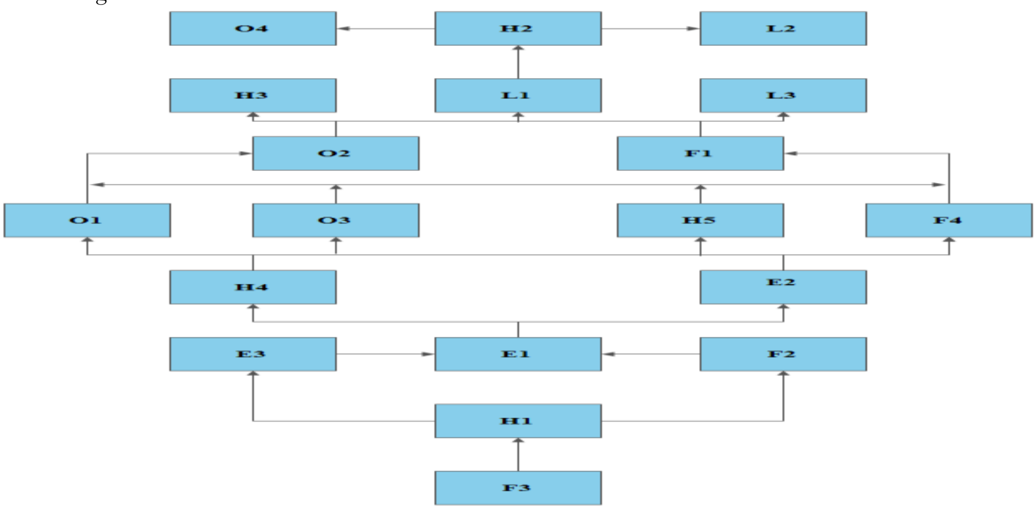

Figure 2. ISM-based model for inhibitors to Sustainability in HL

4.3. Practical implications

The article has three important implications. (i), This article aims to investigate the interrelationships and fundamental reasons for the inhibitors to sustainability in HL. The article highlights the interrelationships among the inhibitors and emphasizes the require focusing on the issues very important that require a strategic orientation and require policy implementation. HOs along with government can improve their performance by controlling the inhibitors to sustainability for appropriate implementation in HL and may bring sustainability in HL. (ii), The ISM model offers a mode to prioritize inhibitors to sustainability. This is the key to steering sustainability in HL. The identified hierarchy may also assist overcome the situation after a disaster strikes. In short, the ISM model can assist to obtain useful arrangements, monitoring, accountability, and corporate governance of the organization. (iii), The study applies the ISM approach which has never been used in this context, which not only shows the interrelationships among the variables but also their importance, which is simple to understand.

4.4. Future Research Directions

The article's findings are not merely useful for implications but also contribute to the field of research. First, sustainability in HL has merely been weakly studied so far. Therefore, this research releases new awareness of this specific subject and contributes a new perception to the present literature. However, this investigation has not elucidated the sustainability inhibitors in HL. Henceforth, future research can use quantitative data to explain statistically the present state of inhibitors to sustainability. Second, even though HOs want to help victims of disaster, difficulties in the path of such contribution can arise due to some reasons such as poor performance measurement system (Haavisto & Kovács, 2014; Khan, Hussain, et al., 2020; Narayana et al., 2019)and Poor resource utilization (John et al., 2019). HOs have been examined systematically but very little attention has been offered in the context of the inhibitors to sustainability in HL, which need to be examined further. Third, the confirmed hierarchy model of the study extends mutual relationships among the investigated inhibitors of sustainability. Further investigation may consider developing a quantitative study to measure sustainability in HL. This quantitative study may be valuable for bench-marking HL on sustainability variables. Fourth, the scholars may work and should address the issues related to the remoteness between the funders and disaster area, which is the root cause in our proposed ISM model, and which cannot be effectively addressed by HOs by themselves without proper investigation. Fifth, the integrated ISM model is developed, and the interrelationship between two inhibitors is indicated by an arrow. Nevertheless, the interrelationship between the inhibitors maybe different such as some linkage may be strong, some associations may be very strong, and some linkages may be superior. To overcome this issue of ISM model, further research is needed to predict the exact interrelationship among these variables. Lastly, this study was based on the findings of the ISM approach. The ISM model extends is based on contributions of resource persons, henceforth, there may chance of biasness. Further multiple methods may contribute maximum to the existing literature.

5. Conclusion

Researchers in the HL field are applying a variety of approaches to investigate the complicated issues of HL. Sustainability implementation is a very complex issue owing to complications of HL process and the involvement of multiple stakeholders. The study has identified 19 basic inhibitors by studying relevant existing literature and through the brainstorming method. It is noted that no isolated inhibitor of sustainability could be self-determining for sustainability implementation in HL. Nevertheless, it is vital to identify the interrelation of inhibitors of sustainability with one another. This study applied ISM approach to extend an interrelationship model for the inhibitors to sustainability in HL.MICMAC analysis is used to recognize the driver and reliance of inhibitors on sustainability by applying ISM approach. Diagraph in figure 1, reflects that the Remoteness between the funders and disaster area is an important inhibitor to sustainability having high driving power. So, management needs to focus on the identified inhibitors for proper implementation of sustainability in HL. As mentioned, in this study integrated hierarchal model of sustainability is extended that can be supportive to HOs to apply this model for identifying and classifying the importance of sustainability of their needs and to denote the influence either direct or indirect of each inhibitor on the sustainability implementation. Therefore, this study could add to the existing literature on HL and could support knowing the basic causes behind the HL sustainability. The study has contributed to literature by identifying and systemizing the barriers to sustainable HL.

References

Ali, A., Khan, M., Ishaq, A., Hussain, A., Rehman, S. U., Khan, I. A., & Shah, S. F. A. (2020). Pakistan Textiles can Bounce Back Vigorously. *International Review of Management and Marketing, 10*(2), 30-40. doi: https://doi.org/10.32479/irmm.9377

Apte, A., Gonçalves, P., & Yoho, K. (2016). Capabilities and competencies in humanitarian operations. *Journal of Humanitarian Logistics and Supply Chain Management, 6*(2), 240-258.

Asgary, R., & Lawrence, K. (2020). Evaluating underpinning, complexity and implications of ethical situations in humanitarian operations: qualitative study through the lens of career humanitarian workers. *BMJ open, 10*(9), e039463.

Babatunde, S., Oloruntoba, R., & Agho, K. (2020). Healthcare commodities for emergencies in Africa: review of logistics models, suggested model and research agenda. *Journal of Humanitarian Logistics and Supply Chain Management*.

Bag, S., Luthra, S., Venkatesh, V., & Yadav, G. (2020). Towards understanding key enablers to green humanitarian supply chain management practices. *Management of Environmental Quality: An International Journal*.

Bealt, J., Fernández Barrera, J. C., & Mansouri, S. A. (2016). Collaborative relationships between logistics service providers and humanitarian organizations during disaster relief operations. *Journal of Humanitarian Logistics and Supply Chain Management, 6*(2), 118-144.

Burkart, C., Besiou, M., & Wakolbinger, T. (2016). The funding—Humanitarian supply chain interface. *Surveys in Operations Research and Management Science, 21*(2), 31-45.

Cao, C., Li, C., Yang, Q., Liu, Y., & Qu, T. (2018). A novel multi-objective programming model of relief distribution for sustainable disaster supply chain in large-scale natural disasters. *Journal of cleaner production, 174*, 1422-1435.

Cao, C., Liu, Y., Tang, O., & Gao, X. (2021). A fuzzy bi-level optimization model for multi-period post-disaster relief distribution in sustainable humanitarian supply chains. *International Journal of Production Economics, 235*, 108081.

Cao, X., Liang, F., Chen, H., & Liu, Y. (2017). Circuity characteristics of urban travel based on GPS data: A case study of Guangzhou. *Sustainability, 9*(11), 2156.

Chen, L., Zhao, X., Tang, O., Price, L., Zhang, S., & Zhu, W. (2017). Supply chain collaboration for sustainability: A literature review and future research agenda. *International Journal of Production Economics, 194*, 73-87.

Cozzolino, A. (2012). Humanitarian logistics and supply chain management *Humanitarian logistics* (pp. 5-16): Springer.

Day, J. M., Melnyk, S. A., Larson, P. D., Davis, E. W., & Whybark, D. C. (2012). Humanitarian and disaster relief supply chains: a matter of life and death. *Journal of Supply Chain Management, 48*(2), 21-36.

Dey, A., LaGuardia, P., & Srinivasan, M. (2011). Building sustainability in logistics operations: a research agenda. *Management Research Review, 34*(11), 1237-1259.

Dolinskaya, I., Besiou, M., & Guerrero-Garcia, S. (2018). Humanitarian medical supply chain in disaster response. *Journal of Humanitarian Logistics and Supply Chain Management*.

Dubey, R., Gunasekaran, A., Altay, N., Childe, S. J., & Papadopoulos, T. (2016). Understanding employee turnover in humanitarian organizations. *Industrial and Commercial Training, 48*(4), 208-214.

Elalouf, A., Hovav, S., Tsadikovich, D., & Yedidsion, L. (2015). Minimizing operational costs by restructuring the blood sample collection chain. *Operations Research for Health Care, 7*, 81-93.

Eskandarpour, M., Dejax, P., Miemczyk, J., & Péton, O. (2015). Sustainable supply chain network design: An optimization-oriented review. *Omega, 54*, 11-32.

Faisal, M. N. (2010). Analysing the barriers to corporate social responsibility in supply chains: an interpretive structural modelling approach. *International Journal of Logistics: Research and Applications, 13*(3), 179-195.

Gimenez, C., Sierra, V., & Rodon, J. (2012). Sustainable operations: Their impact on the triple bottom line. *International Journal of Production Economics, 140*(1), 149-159.

Goldsby, T. J., & Stank, T. P. (2000). World class logistics performance and environmentally responsible logistics practices. *Journal of Business logistics, 21*(2), 187.

Gonzalez, E. D., Sarkis, J., Huisingh, D., Huatuco, L. H., Maculan, N., Montoya-Torres, J. R., & De Almeida, C. M. (2015). Making real progress toward more sustainable societies using decision support models and tools: introduction to the special volume. *Journal of cleaner production, 105*, 1-13.

Guiffrida, A. L., Datta, P., Dey, A., LaGuardia, P., & Srinivasan, M. (2011). Building sustainability in logistics operations: a research agenda. *Management Research Review, 34*(11), 1237-1259.

Gunasekaran, A., & Spalanzani, A. (2012). Sustainability of manufacturing and services: Investigations for research and applications. *International Journal of Production Economics, 140*(1), 35-47.

Haavisto, I., & Kovacs, G. (2013). Sustainability in humanitarian operations. *Sustainable Value Chain Management Analyzing, Designing, Implementing, and Monitoring for Social and Environmental Responsibility*.

Haavisto, I., & Kovács, G. (2014). Perspectives on sustainability in humanitarian supply chains. *Disaster Prevention and Management, 23* (5), 610-631. doi: https://doi.org/10.1108/DPM-10-2013-0192

Holguín-Veras, J., & Jaller, M. (2012). Immediate resource requirements after hurricane Katrina. *Natural Hazards Review, 13*(2), 117-131.

Hu, Z.-H., & Sheu, J.-B. (2013). Post-disaster debris reverse logistics management under psychological cost minimization. *Transportation research part B: methodological, 55*, 118-141.

Jaehn, F. (2016). Sustainable operations. *European Journal of Operational Research, 253*(2), 243-264.

John, L., Gurumurthy, A., Soni, G., & Jain, V. (2019). Modelling the inter-relationship between factors affecting coordination in a humanitarian supply chain: a case of Chennai flood relief. *Annals of Operations Research, 283*(1), 1227-1258.

Kamba, P. F., Ireeta, M. E., Balikuna, S., & Kaggwa, B. (2017). Threats posed by stockpiles of expired pharmaceuticals in low-and middle-income countries: a Ugandan perspective. *Bulletin of the World Health Organization, 95*(8), 594.

Khan, M., Hussain, A., Farooq, N., Sahibzada, S., Khattak, A., & Malik, S. (2020). Applying Interpretive Structural Modeling and MICMAC Analysis to Evaluate Inhibitors to Transparency in Humanitarian Logistics. *utopia y Praxis Latinoamericana, 25*(2), 325-337.

Khan, M., Khan, M., Ali, A., Khan, M. I., Ullah, I., & Iqbal, M. (2022). Digitalization for Fast, Fair, and Safe Humanitarian Logistics. *Logistics, 6*(2), 31.

Khan, M., Lee, H. Y., & Bae, J. H. (2019). The Role of Transparency in Humanitarian Logistics. *Sustainability, 11*(7), 2078.

Khan, M., Parvaiz, G. S., Ali, A., Jehangir, M., Hassan, N., & Bae, J. (2022). A Model for Understanding the Mediating Association of Transparency between Emerging Technologies and Humanitarian Logistics Sustainability. *Sustainability, 14*(11), 6917.

Khan, M., Sarmad, M., Ullah, S., & Bae, J. (2020). Education for sustainable development in humanitarian logistics. *Journal of Humanitarian Logistics and Supply Chain Management, 10*(4), 573-602.

Khan, M., Yong, L. H., & Han, B. J. (2019a). Emerging Techniques for Enhancing the Performance of Humanitarian Logistics. *Int. J Sup. Chain. Mgt Vol, 8*(2), 450.

Khan, M., Yong, L. H., & Han, B. J. (2019b). A Systematic Review of Performance Enhancement of Humanitarian Logistics through Transparency: Current Status and Perspectives. *Int. J Sup. Chain. Mgt Vol, 8*(2), 549.

Klumpp, M., De Leeuw, S., Regattieri, A., & De Souza, R. (2015). *Humanitarian logistics and sustainability*: Springer.

Kunz, N., & Gold, S. (2017). Sustainable humanitarian supply chain management–exploring new theory. *International Journal of Logistics Research and Applications, 20*(2), 85-104.

Laguna-Salvadó, L., Lauras, M., Okongwu, U., & Comes, T. (2019). A multicriteria Master Planning DSS for a sustainable humanitarian supply chain. *Annals of Operations Research, 283*(1), 1303-1343.

Li, C., Zhang, F., Cao, C., Liu, Y., & Qu, T. (2019). Organizational coordination in sustainable humanitarian supply chain: An evolutionary game approach. *Journal of cleaner production, 219*, 291-303.

Lieb, K. J., & Lieb, R. C. (2010). Environmental sustainability in the third-party logistics (3PL) industry. *International journal of physical distribution & logistics management, 40*(7), 524-533.

Mandal, A., & Deshmukh, S. (1994). Vendor selection using interpretive structural modelling (ISM). *International Journal of Operations & Production Management, 14*(6), 52-59.

McDonald, S., Fabbri, A., Parker, L., Williams, J., & Bero, L. (2019). Medical donations are not always free: an assessment of compliance of medicine and medical device donations with World Health Organization guidelines (2009–2017). *International health, 11*(5), 379-402.

Mollenkopf, D., Stolze, H., Tate, W. L., & Ueltschy, M. (2010). Green, lean, and global supply chains. *International journal of physical distribution & logistics management, 40*(1-2), 14-41.

Muller, A., & Whiteman, G. (2009). Exploring the geography of corporate philanthropic disaster response: A study of Fortune Global 500 firms. *Journal of business ethics, 84*(4), 589-603.

Narayana, S. A., Pati, R. K., & Padhi, S. S. (2019). Market dynamics and reverse logistics for sustainability in the Indian Pharmaceuticals industry. *Journal of cleaner production, 208*, 968-987.

Nurmala, N., Nurmala, N., de Leeuw, S., de Leeuw, S., Dullaert, W., & Dullaert, W. (2017). Humanitarian–business partnerships in managing humanitarian logistics. *Supply Chain Management: An International Journal, 22*(1), 82-94.

Patil, A., Shardeo, V., Dwivedi, A., Madaan, J., & Varma, N. (2021). Barriers to sustainability in humanitarian medical supply chains. *Sustainable Production and Consumption, 27*, 1794-1807.

Pomponi, F., Moghayedi, A., Alshawawreh, L., D'Amico, B., & Windapo, A. (2019). Sustainability of post-disaster and post-conflict sheltering in Africa: What matters? *Sustainable Production and Consumption, 20*, 140-150.

Rabta, B., Wankmüller, C., & Reiner, G. (2018). A drone fleet model for last-mile distribution in disaster relief operations. *International Journal of Disaster Risk Reduction, 28*, 107-112.

Raila, E. M., & Anderson, D. O. (2017). Healthcare waste management during disasters and its effects on climate change: Lessons from 2010 earthquake and cholera tragedies in Haiti. *Waste Management & Research, 35*(3), 236-245.

Rajeev, A., Pati, R. K., Padhi, S. S., & Govindan, K. (2017). Evolution of sustainability in supply chain management: A literature review. *Journal of cleaner production, 162*, 299-314.

Raut, R. D., Mangla, S. K., Narwane, V. S., Dora, M., & Liu, M. (2021). Big Data Analytics as a mediator in Lean, Agile, Resilient, and Green (LARG) practices effects on sustainable supply chains. *Transportation Research Part E: Logistics and Transportation Review, 145*, 102170.

Remida, A. (2015). A systemic approach to sustainable humanitarian logistics *Humanitarian Logistics and Sustainability* (pp. 11-29): Springer.

Rossi, S., Colicchia, C., Cozzolino, A., & Christopher, M. (2013). The logistics service providers in eco-efficiency innovation: an empirical study. *Supply Chain Management: An International Journal, 18*(6), 583-603.

Sabri, Y., Zarei, M. H., & Harland, C. (2019). Using collaborative research methodologies in humanitarian supply chains. *Journal of Humanitarian Logistics and Supply Chain Management*.

Sabuj, S. U., Ali, S. M., Hasan, K. W., & Paul, S. K. (2021). Contextual relationships among key factors related to environmental sustainability: Evidence from an emerging economy. *Sustainable Production and Consumption, 27*, 86-99.

Sarkis, J., Spens, K. M., & Kovács, G. (2013). A study of barriers to greening the relief supply chain *Supply Chain Management: Concepts, Methodologies, Tools, and Applications* (pp. 1407-1417): IGI Global.

Sherrington, C., & Moran, D. (2010). Modelling farmer uptake of perennial energy crops in the UK. *Energy Policy, 38*(7), 3567-3578.

Shi, Y., Wang, H., & Shi, S. (2019). Relationship between social civilization forms and carbon emission intensity: a study of the Shanghai metropolitan area. *Journal of cleaner production, 228*, 1552-1563.

Shin, N., & Park, S. (2019). Evidence-Based Resilience Management for Supply Chain Sustainability: An Interpretive Structural Modelling Approach. *Sustainability, 11*(2), 484.

Thomas, A., & Mizushima, M. (2005). Logistics training: necessity or luxury. *Forced Migration Review, 22*(22), 60-61.

Vega-Mejía, C. A., Montoya-Torres, J. R., & Islam, S. M. (2019). Consideration of triple bottom line objectives for sustainability in the optimization of vehicle routing and loading operations: a systematic literature review. *Annals of Operations Research, 273*(1), 311-375.

Viegas, C. V., Bond, A., Vaz, C. R., & Bertolo, R. J. (2019). Reverse flows within the pharmaceutical supply chain: A classificatory review from the perspective of end-of-use and end-of-life medicines. *Journal of cleaner production, 238*, 117719.

Vitoriano, B., Ortuño, M. T., Tirado, G., & Montero, J. (2011). A multi-criteria optimization model for humanitarian aid distribution. *Journal of Global Optimization, 51*(2), 189-208.

Zhang, B., Li, H., Li, S., & Peng, J. (2018). Sustainable multi-depot emergency facilities location-routing problem with uncertain information. *Applied Mathematics and Computation, 333*, 506-520.